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Morphometric studies on *Anopheles gambiae* complex (Diptera: Culicidae) in Abeokuta, Southwest Nigeria

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Abstract: Morphometric analysis of *Anopheles gambiae* complex was carried out in Abeokuta metropolis. Six characters including the antennal length, wing length, proboscis length, fore leg length, mid leg length and hind leg length, were measured in 364 individual samples of *Anopheles gambiae* complex collected between August 2005 and July 2006 using light traps. The monthly mean length of each character was subject to regression analysis while co-efficient of difference (CD) was used to determine the presence of sibling species. The results revealed that the mean length in each character was higher for the wet season population as compared with the dry season population. However, the regression analysis showed that the variation was not season specific ($P > 0.05$). Only the antennal length and wing length indicated two distinct populations when subjected to co-efficient of difference ($CD > 1.28$), while other characters indicated one population. The results therefore suggest that the antennal length and wing length may be of significant value in sorting siblings of *A. gambiae* complex in the study area.

Key words: *Anopheles gambiae* complex; morphometric analysis; sibling species; seasonal population; Abeokuta; Nigeria

1 INTRODUCTION

Results of various biological data on adult mosquitoes over the years had revealed differences in characteristics of some species depending on the ecotypes and the season (Lehane, 1991). For example, the host seeking behaviour and vectorial capacity of some members of *Anopheles gambiae* and *A. funestus* differ significantly in different geographical zones of the world. It was later discovered that the two species are of a complex made up of the reproductively isolated siblings, which are morphologically indistinguishable (Gillies and DeMeillon 1968; Gillies and Cortzee, 1987).

Due to the observed differences in vectorial capacities and behavioural habits of the siblings in species complexes, efforts have been geared toward identifying the siblings of mosquito species (Wilkerson and Pyton, 1991). One of these efforts is the use of multivariate techniques such as morphometrics (Garms, 1978; Jakob *et al*., 1980; Wilkerson and Pyton, 1991)

However, few reports are available on morphometric studies on local mosquito species in Africa. And in few areas where attempts had been made, the results may be insignificant for other locations considering the difference in geographical zones. This work was therefore carried out to investigate morphometric variations in *A. gambiae* complex in Abeokuta, Ogun State, Nigeria.

2 MATERIALS AND METHODS

2.1 Study area

Abeokuta lies on the latitude 7°10′N and longitude 3°2′E in the transitional zone between the tropical rainforest and derived savannah zone of Nigeria. Abeokuta experiences two seasons; the dry season (November to March) and the wet season (April to October).

2.2 Collection of adult mosquitoes

Adult mosquitoes were collected in five randomly selected locations within Abeokuta metropolis, namely Obantoko, Kugba, Ijaye, Ago-Ika and Ibara. Mosquitoes were collected weekly in three randomly

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selected houses in each of the study locations using Centre for Disease Control (CDC) light traps between August 2005 and July 2006. The traps were operated between 8:00 pm and 6:00 am in each catching night. All mosquitoes collected in the traps were removed and kept in labeled EDTA bottles for laboratory analysis.

A. gambiae complex were sorted out of other mosquitoes using keys described by Gillet (1972) with the aid of dissecting microscope. Six characters were measured in each of the *A. gambiae* complex using calibrated microscope. The characters measured are antennal length, proboscis length, wing length, fore leg length, mid leg length and hind leg length.

2.3 Statistical analysis

Monthly means of all measured characters were subject to regression analysis. Co-efficient of difference (CD) was calculated for each character having at least two peaks after the frequency distribution of the grouped data has been plotted. The co-efficient of difference was calculated as described by Mayr (1969).

$$CD = (Mb - Ma)/(SDa + SDb)$$

Where CD = Co-efficient of difference; Mb = Population with the larger mean; Ma = Population with the smaller mean; SDb = Standard deviation of the population with the larger mean; SDa = Standard deviation of the population with the smaller mean.

3 RESULTS

A total 364 individual samples of *A. gambiae* complex were caught during the period of the study. The mean length of the characters is presented in Table 1. The result showed that the mean length was higher in each character for the wet season population as compared with the dry season population. However, the regression analysis revealed that the variation was not season specific($P > 0.05$).

Table 1 Mean length of the studied charaters in *Anopheles gambiae* complex in the study locations in Abeokuta

Characters (mm)	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
Antennal length	0.93	0.98	0.92	0.99	0.94	0.91	0.93	0.92	0.96	1	0.94	0.94
Wing length	2.5	2.65	2.62	2.64	2.63	2.53	2.54	2.51	2.51	2.56	2.57	2.5
Proboscis length	1.42	1.49	1.44	1.49	1.44	1.41	1.43	1.35	1.42	1.43	1.47	1.43
Fore leg length	4.67	4.63	4.62	4.62	4.63	4.66	4.68	4.66	4.67	4.65	4.61	4.69
Mid leg length	5.56	5.54	5.53	6.54	5.53	5.57	5.56	5.43	5.57	5.57	5.53	5.54
Hind leg length	6.13	6.19	6.14	6.19	6.16	6.16	6.18	6.22	6.19	6.17	6.21	6.29

When the data was pooled and the frequency distribution was plotted against size classes, only the antennal length and wing length indicated two peaks, while the other characters showed one peak (Fig.1).

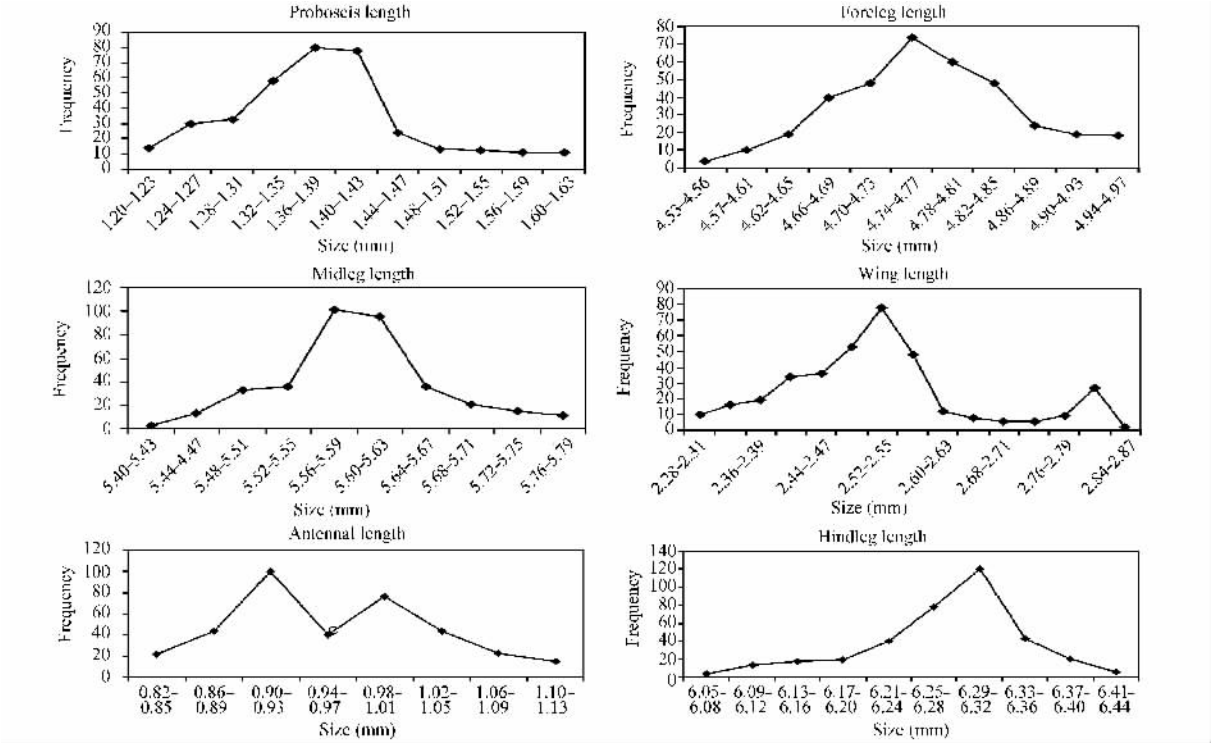

Fig. 1 Variation in mean length of the studied characters in *Anopheles gambiae* complex in the study locations in Abeokuta

Each of the peaks exhibited by antennal length and wing length was assumed as a different population. The result of co-efficient of difference when calculated for each of the populations also indicated two distinct populations (Table 2).

Table 2 Morphometric analysis of *Anopheles gambiae* complex in the study locations in Abeokuta

Character	Population	Mean (mm)	*SD*	CD
Antennal length	A	0.91	0.003	AB = 5.71
	B	0.99	0.011	
Wing length	A	2.53	0.013	AB = 9.3
	B	2.81	0.018	

SD = standard deviation; CD = co-efficient of difference (CD value > 1.28 is significant).

4 DISCUSSION AND CONCLUSION

Morphometric discrimination had long been used in sorting siblings of some insects. For instance, the use of distance between the tip of the genital arm and its intersection with dorsal arm in *Culex pipens* complex (Pryor and Daly, I991), the length and shape of antennae of *Simulium damnosum* s.l, (Quillevere *et al*., 1997), and eye base to bucca tip length in *Glossinidae* (Adesiyan *et al*., 1998). The results of this study showed variation in the used characters, which was not season dependent. However, the wing length and the antennal length indicated two probable populations. *A. gambiae* complex has been known to consist of six similar siblings which can be distinguished to some extent by their larval ecology (Lehane, 1991). Only *A. gambiae*, *A. arabiensis* and *A. quadrianulatus* breed in freshwater. Other siblings are brackish water breeders.

Since the water bodies present within the metropolis are fresh water, the members of complex likely to be present in the study area are fresh water breeders. Due to the fact that *A. quadrianulatus* is zoophilic (Service, 1999) and its presence is rarely seen around human shelter, *A. gambiae* and *A. arabiensis* are siblings likely to be present in this study. Incidentally, earlier reports on molecular characterization on *A. gambiae* complex in most part of Nigeria had also revealed the presence of only *A. gambiae* and *A. arabiensis* (Awolola *et al*., 2005; Oyewole *et al*., 2005). Though, it is difficult to infer at this level the corresponding population for each of the two siblings since there is patchy record on the morphological discrimination of the siblings, further studies by comparing the genetic composition with measured characters will give valuable clues to identifying the sibling that corresponds to each population in the study area.

It is therefore worthy to note that the wing length and antennal length may be of significant value in distinguishing siblings of *A. gambiae* complex in the study area as alternative to molecular analysis. Further studies are still recommended on morphometric studies on *A gambiae* complex in Abeokuta so as to document as many discriminating characters as possible.

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尼日利亚南部阿贝奥库塔地区冈比亚按蚊复合体的形态特征研究
（双翅目:蚊科）

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摘要：对采自尼日利亚南部城市阿贝奥库塔冈比亚按蚊复合体 *Anopheles gambiae* complex 的形态特征进行了研究。依据 2005 年 8 月至 2006 年 7 月灯诱捕获的 364 个冈比亚按蚊复合体标本，分别对它们的触角、翅、喙、前足、中足和后足 6 个部位的长度进行了测量，对月平均值进行回归分析，同时利用差异系数（co-efficient of difference, CD）进行近缘分析。分析显示，各特征的长度平均值雨季大于旱季，但是回归分析表明长度变化与季节不显著相关（$P > 0.05$）。差异系数分析结果表明，仅触角长度和翅长显示此复合体为两个不同的种群（CD > 1.28），而其他特征值表明为同一种群。因此，该研究结果提示触角长度及翅长对冈比亚按蚊复合体近缘种的区分有重要参考价值。

关键词：冈比亚按蚊复合体；形态分析；近缘种；季节种群；阿贝奥库塔；尼日利亚

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